Simpson

INSTRUMENTS THAT STAY ACCURATE

OPERATOR'S MANUAL

SIMPSON 463 DIGITAL MULTIMETER

WARNING

For safe usage, it is essential that the operator read this manual carefully before using the instrument for any measurements.

SIMPSON ELECTRIC COMPANY

853 Dundee Ave., Elgin, Illinois 60120

Area Code, 312, Telephone 697-2260

In Canada, Bach-Simpson, Ltd., London, Ontario

DIGITAL INSTRUMENT Warranty

SIMPSON ELECTRIC COMPANY warrants each digital instrument manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any digital instrument which shall within one (1) year after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service stations, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products.

This warranty shall not apply to any digital instrument which shall have been repaired or altered outside the SIMPSON ELECTRIC COMPANY factory or authorized service stations, nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation or use not in accord with instructions furnished by the manufacturer.

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KATY INDUSTRIES
INDUSTRIAL EQUIPMENT GROUP

OPERATOR'S MANUAL

SIMPSON 463
DIGITAL MULTIMETER

This symbol on the nameplate means the product is Listed by Underwriters Laboratories Inc.

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NOTE: This Operator's Manual contains information essential to the operation of this Instrument. Therefore, it should be kept in a convenient place and used for reference as required.

SAFETY SYMBOLS

This marking adjacent to another marking or a terminal or Operating device indicates that the Operator must refer to an explanation in the Operating Instructions to avoid damage to the equipment and/or to avoid personal injury.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, which if not correctly performed or adhered to, could result in personal injury.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to a procedure, practice or the like, which if not correctly adhered to could result in damage to or destruction of part or all of the Instrument.

HIGH VOLTAGE TERMINAL: A terminal at which a voltage, with respect to another terminal or part exists or may be adjusted to 1000 volts or more. The symbol is an additional warning that a very dangerous voltage may exist at the terminal, and its connecting leads must not be handled while energized.

GROUNDED TERMINAL (PROTECTIVE): A terminal which must be connected to earth ground by the Operator or Installer prior to making any other connections to the equipment for personal protection from electrical shock.

GROUNDED TERMINAL: A terminal which is connected to earth ground by means of an earth grounding system and which is intended to be connected to other circuits or equipment by the Operator or Installer for purposes other than protection from electrical shock.

WARNING

This Instrument is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely before making any measurements. Failure to follow directions can result in a serious or fatal accident.

SHOCK HAZARD: As defined in American National Standard, C39.5, Safety Requirements for Electrical & Electronic Measuring & Controlling Instrumentation, a shock hazard shall be considered to exist at any part involving a potential in excess of 30 volts rms (sine wave) or 42.4 volts DC or peak and where a leakage current from that part to ground exceeds 0.5 milliampere, when measured with an appropriate measuring instrument defined in Section 11.6.1 of ANSI C39.5.

NOTE: The proper measuring instrument for the measurement of leakage current consists essentially of a network of a 1500 ohms non-inductive resistor shunted by a 0.15 microfarad capacitor connected between the terminals of the measuring instrument. The leakage current is that portion of the current that flows through the resistor. The Simpson Model 229-Series 2 AC Leakage Current Tester meets the ANSI C39.5 requirements for the measurement of AC leakage current and can be used for this purpose. To measure DC Leakage current, connect a 1500 ohm non-inductive resistor in series with a Simpson 0-500 DC microammeter and use this as the measuring instrument.

Figure 1-1. Digital Multimeter, 463.

SECTION I
INTRODUCTION

1.1 GENERAL

1.1.1 The Simpson 463 Digital Multimeter (hereafter referred to as the 463 or simply the Instrument), is a portable 3½ digit, compact instrument suitable for use in general electronic maintenance, production, and laboratory. This multimeter is designed for the service person who values true portability, reliability, simplicity, and the ruggedness of a precision instrument. It features, 0.2% DC voltage accuracy, single 9V battery operation, large LCD display, transient suppression capability and pushbutton switch selection for ranges and functions. Additional features are automatic polarity, automatic zeroing, high input impedance for voltage measurements, and excellent overload protection characteristics.

1.1.2 The 463 measures DC and AC voltage, DC and AC current and resistance as specified in Table 1-1. The Analog-To-Digital (A/D) conversion circuitry is contained in one Large-Scale-Integration (LSI) module which provides high reliability and compact design.

1.1.3 The 463 is designed to operate continuously for 200 hours using a single 9V alkaline "transistor" battery (NEDA 1604A). However, a carbon-zinc type battery (NEDA 1604) may be substituted. (Operation will be reduced to 100-150 hours.) An arrow on the display is used to indicate low battery voltage and signify a battery life of 20 hours remaining.

1.1.4 The numerical display is a 3½ digit, 7-segment liquid crystal display (LCD). The high contrast

numerals are 0.5 inches high and are in a single plane for distant and wide angle viewing.

1.2 SUPPLIES AND ACCESSORIES

1.2.1 All supplies and accessories required for the operation of the 463 are furnished with the Instrument, and listed in the accompanying Table 1-2. Available replacement parts are listed in Table 6-2.

1.3 SAFETY CONSIDERATIONS

1.3.1 This Operator's Manual contains cautions and warnings alerting the user to hazardous operating and service conditions. This information is flagged by CAUTION or WARNING headings throughout this publication, where applicable, and are defined at the front of the manual under SAFETY SYMBOLS. To ensure the safety of operating and servicing personnel and to retain the operating conditions of the instrument these instructions must be adhered to.

1.4 TECHNICAL DATA

1.4.1 Table 1-1 lists the technical specifications for the 463 Digital Multimeter.

Table 1-1. Technical Data

1. DC VOLTAGE:	
Ranges:	200mV, 2V, 20V, 200V, 1000V
Accuracy: (from +20°C to +30°C)	±(0.2% of reading + 1 digit)
Input Resistance:	10MΩ, All Ranges

Overload Protected To: 1100V (DC + peak AC), All Ranges

Sensitivity: 100μV on 200mV range

Full Range Step Response (to rated accuracy): 1 second

Normal Mode Rejection: 50dB minimum at 60Hz

Common Mode Rejection: 120dB minimum at 60Hz

2. AC VOLTAGE (Average-Sensing, rms Calibrated Sine Wave)

Ranges: 200mV, 2V, 20V, 200V, 750V

Accuracy (from +20°C to +30°C):

Range	20 Hz to 40 Hz	40 Hz to 400 Hz	400 Hz to 1 kHz	1 kHz to 10 kHz	10 kHz to 20 kHz
200mV	* ±(1.5% +3)	±(0.5% +2)		±(1.5% +3)	±(5% +5)
2V					
20V					
200V					
750V					

**% of reading + number of digits*

Input Impedance: 10MΩ and 100pF All Ranges

Overload Protected To: 1100V (DC + peak AC), All Ranges

Full Range Step Response (to rated accuracy):	3 seconds

3. RESISTANCE:

Ranges:	200Ω, 2kΩ, 20kΩ, 200kΩ 2000kΩ, 20MΩ
Accuracy: (from +20°C to +30°C)	±(0.25% of reading +2 digits) except on the 20MΩ range which is ±(0.75% of reading +2 digits)
Open Circuit Voltage:	<3.5V, All Ranges
Overload Protected To:	250 VRMS, All Ranges
Full Range Step Response (to rated accuracy):	1 second except on 20MΩ range which is 7 seconds.

4. DC CURRENT:

Ranges:	200μA, 2mA, 20mA, 200mA, 2000mA
Accuracy (from +20°C to +30°C):	±(0.5% of reading +2 digits) except on 2000mA range which is ±(1.0% of reading +2 digits)
Full Range Voltage Drop:	200mV All Ranges
Overload Protected To:	±2A Fuse Protected, All Ranges

Full Range Step Response (to rated accuracy):	1 second

5. AC CURRENT: (40 Hz to 5kHz)

Ranges:	200μA, 2mA, 20mA, 200mA, 2000mA
Accuracy: (from +20°C to +30°C):	±(1.5% of reading +3 digits) 40Hz to 1 kHz ±(5% of reading +5 digits) 1 kHz to 5 kHz
Full Range Voltage Drop:	200mV, All Ranges
Overload Protected To:	2A Fuse Protected, All Ranges
Full Range Step Response (to rated accuracy):	3 seconds

6. RATED CIRCUIT-TO-GROUND VOLTAGE (max common mode voltage): ⚠ 1000 volts (DC plus peak AC) from any measuring terminal to power line (earth) ground terminal.

7. TRANSIENT PROTECTION: Protected against transients on all voltage and resistance ranges: 10kV for 1μS max, 6kV for 100μS max.

8. DISPLAY:

Numerical Display:	3½ digit, 7-segment

	liquid crystal display (LCD) type, with "low battery" indication
Conversion Rate:	3 readings per second, nominal
DC Polarity Selection:	Automatic "—" indication, "+" sign implied.

9. POWER REQUIREMENT:

Battery Type:	(1) 9-volt "transistor" battery alkaline (NEDA 1604A) or carbon-zinc (NEDA 1604)
Battery Life:	200 hours with alkaline battery

10. TEMPERATURE RANGE:

Operating:	5°C to +40°C
Storage:	— 40°C to +60°C

11. TEMPERATURE COEFFICIENT: (5°C to +20°C and +30°C to +40°C) Less than 0.1 times the applicable accuracy specification per °C.

12. HUMIDITY RANGE: 95% max., +5°C to +30°C

75% max., +30°C to +40°C

13. DIMENSIONS:

Height:	2″ (50.8mm)
Width:	5.63″ (143mm)
Depth:	4.6″ (116.8mm)

14. WEIGHT: 1.0 lb. (.453 kg)

Table 1-2. Items and Accessories Furnished With This Instrument

Quantity	Description	Part No.
1	Operator's Manual	6-111162
1	Battery, 9V Alkaline	5-114907
1	Test Lead Set: One black and one red insulated lead having probe tips with provisions for screw-on alligator clips (One red and one black supplied).	10-830676

SECTION II
INSTALLATION

2.1 GENERAL

2.1.1 This section contains information and instructions for the installation and shipping of the 463. Included are unpacking and inspection procedures, warranty, shipping, power source requirements, installation, and care.

2.2 UNPACKING AND INSPECTION

2.2.1 Examine the shipping carton for obvious signs of damage. Inspect the Instrument for possible damage incurred during shipment. If damage is noted, notify the carrier and supplier and do not attempt further use of the Instrument. If the Instrument appears to be in good condition, read the Operator's Manual in its entirety. Become familiar with the Instrument as instructed in the manual, then proceed to check the electrical performance as soon as possible. Also, check that all items are included with the Instrument (Table 1-2).

2.3 WARRANTY

2.3.1 The Simpson Electric Company warranty policy is printed on the inside front cover of this manual. Read it carefully prior to requesting a warranty repair.

> **NOTE:** For assistance of any kind, including help with the Instrument under warranty, contact the nearest Authorized Service Center for instructions (listed on the last pages of this manual). If it's necessary to contact the factory directly, give full details of any

difficulty and include the Instrument model number, serial number (at the back of the Instrument) and date of purchase. Service data or shipping instructions will be mailed promptly. If an estimate of charges for non-warranty or other service work is required, a charge estimate will be quoted. This charge will not be exceeded without prior approval.

2.4 SHIPPING

2.4.1 Pack the Instrument carefully and ship it prepaid to the proper destination. Insure the Instrument.

2.5 POWER SOURCE REQUIREMENTS

2.5.1 The 463 is a battery operated instrument. An alkaline 9V "transistor" battery is factory installed in the instrument. (See item 9, Table 1-1 for battery type and paragraph 6.3 for installation.)

2.6 INSTALLATION

2.6.1 The Instrument may be set horizontally on its rubber feet or vertically on its back and operated in either position. The Instrument can also be set at an inclined angle by positioning the stand under the unit.

2.7 CARE:

WARNING

Do not attempt to clean this Instrument with the test leads connected to a power source.

2.7.1 Immediately clean all spilled materials from the Instrument and wipe dry. If necessary, moisten cloth with soap and water to clean plastic surfaces.

2.7.2 Whenever possible, avoid exposure or usage in areas which are subject to temperature and humidity extremes, vibration or mechanical shock, dust or corrosive fumes, or strong electrical or electromagnetic interference.

2.7.3 MONTHLY CARE: Verify Instrument calibration by performing operational checks using known value sources. If a need for calibration is indicated, contact the nearest Authorized Service Center.

2.7.4 ANNUAL CARE: It is recommended that the Instrument be returned annually to an Authorized Service Center or the factory for a complete overall check and calibration.

2.7.5 STORAGE: When the Instrument is not in use, store it in a location free from temperature extremes, dust, corrosive fumes, and mechanical vibration or shock.

SECTION III

CONTROLS, CONNECTORS, AND INDICATORS

3.1 GENERAL

3.1.1 All operating controls, connectors and indicators are described in Table 3-1. Become familiar with each item prior to operating the Instrument for the first time.

3.2 FRONT AND SIDE PANEL DESCRIPTION

3.2.1 Table 3-1 lists all front and side panel controls, connectors, and indicators (Figures 3-1, 3-2, for identification).

Table 3-1. Front and Side Panel Description

1. POWER SWITCH: ON ▬ OFF ▬	Pushbutton switch used to apply or turn off power to the instrument.
2. FUNCTION SWITCHES:	Connect the input to the appropriate measuring circuits as follows: ⎓ V = DC Voltage ∿ V = AC Voltage ⎓ mA = DC Milliamps ∿ mA = AC Milliamps Ω kΩ = Resistance
3. RANGE SWITCHES:	Selects the appropriate circuits required to obtain full range measurements as follows:

Voltage:	200mV, 2V, 20V, 200V, 1000VDC/750VAC
Current:	200μA, 2mA, 20mA, 200mA, 2000mA
Resistance:	200Ω, 2kΩ, 20kΩ, 200kΩ, 2000kΩ, 20MΩ

4. **NUMERICAL DISPLAY:** The digital display uses LCD's and includes a "—" polarity sign, ("+" sign is implied), a "1" digit, three 7-segment 0 to 9 digits and a decimal point, to indicate the polarity and the value of the signal being measured. The decimal point is properly positioned by the selection of the range switch. Overrange (or out of range) conditions are indicated by a blank

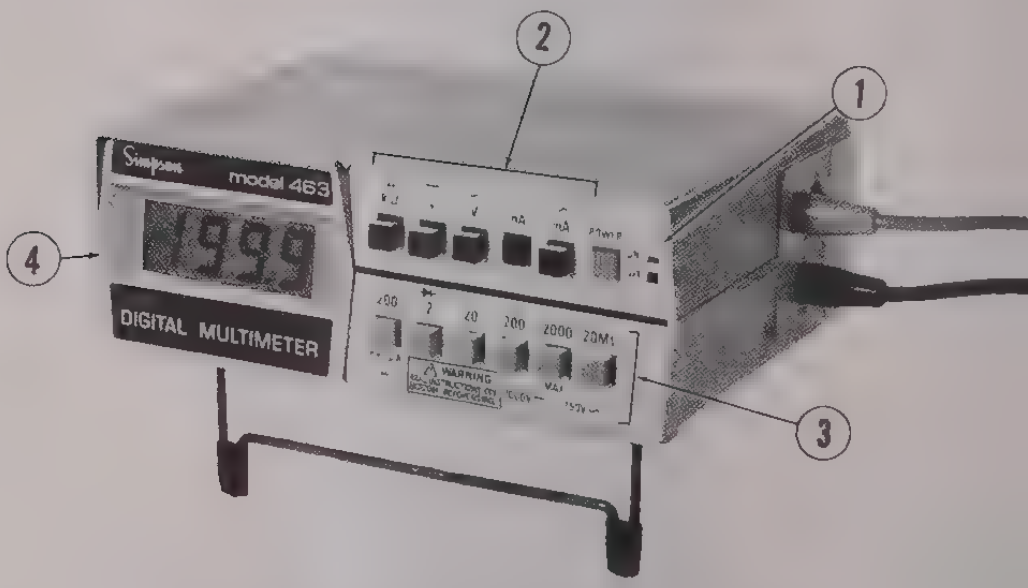

Figure 3-1. Front Panel Description.

display, except for the most significant "1" digit.

Low battery condition is indicated by an arrow (◄) located on the upper left-hand corner of the display. The first appearance of the arrow signifies a remaining battery life of approximately 20 hours.

5. V-Ω JACK: This jack is used to connect, via the red test lead, the "high" or "+" side of the circuit being measured to all voltage and resistance measuring circuits through the range and function switches.

6. COM JACK: This jack is used to connect, via the black test lead, the "low" or "–" side of the circuit being measured

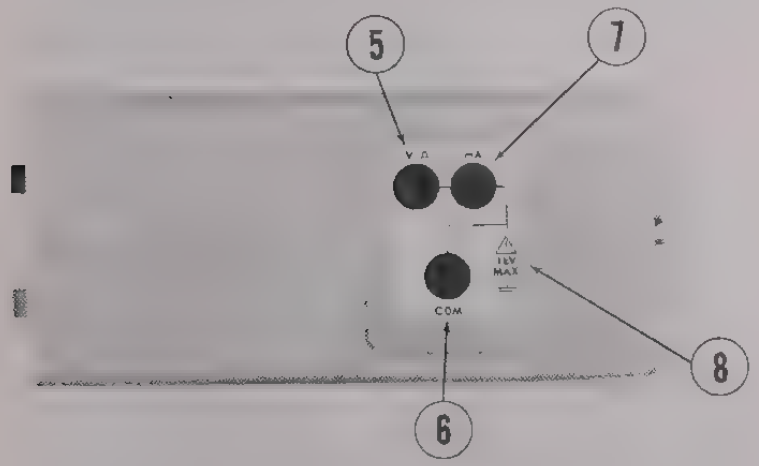

Figure 3-2. Right Side Panel Description.

to the internal circuit COMMON and is isolated from the AC power line ground. Do not float this terminal more than 1000 (DC plus AC peak) volts away from earth ground.

7. mA JACK: This jack is used to connect, via the red test lead, the "high" or "+" side of the circuit being measured to the current measuring circuits through the range and function switches.

8. ⚠ Refer to Table 1-1, item 6.

SECTION IV
OPERATION

4.1 GENERAL

WARNING

Before proceeding with the operation of the 463, review the SHOCK HAZARD definition at the front of this manual.

4.1.1 This section of the manual contains information required to use and operate the 463 in a safe and proper manner.

4.2 SAFETY PRECAUTIONS

4.2.1 The 463 is designed to be used only by personnel qualified to recognize shock hazards and trained in safety precautions required to avoid possible injury.

4.2.2 Do not work alone when making measurements where a shock hazard can exist. Notify another person that you are, or intend to make such measurements.

CAUTION

Voltages might appear unexpectedly in defective equipment. An open bleeder resistor can result in a capacitor retaining a dangerous charge. Remove all power and discharge all capacitors in the circuit being measured before making connections to or disconnections from it. The above precautions are wise even in the laboratory, and especially in field usage of the instrument where many strange or unknown safety hazards might prevail.

4.2.3 Locate all voltage sources and accessible

paths prior to making any measurements or connections.

4.2.4 Before each use, inspect the test leads, prods, and connectors and power cable for cracks, breaks, or crazes in the insulation. If any defects exist, destroy and replace the defective item(s) immediately.

4.2.5 Do not make measurements in a circuit where corona is present. Corona can be identified by a pale blue color eminating from sharp metal points in the circuit or a buzzing sound, or the odor of ozone. In rare instances, such as around germicidal lamps, ozone might be generated as a normal function. Ordinarily, the presence of ozone indicates presence of high voltage, and probably a malfunction of some kind.

4.2.6 Hands, shoes, floor and workbench must be dry. Avoid making measurements under humid, damp, or other environmental conditions that could affect the dielectric withstanding voltage to the test leads of the Instrument.

4.2.7 For maximum safety, do not touch test leads, circuit, or the Instrument while power is applied to the circuit being measured.

4.2.8 Use extreme caution when making measurements where dangerous composite voltages could be present, such as in an rf amplifier.

4.2.9 Do not use test leads which differ from those originally furnished with the Instrument.

4.2.10 Do not float any measuring terminal more than 1000 volt (DC plus AC peak) with respect to the power line or earth ground.

4.3 BATTERY POWER

4.3.1 Type And Life

4.3.2 The 463 is designed to operate on a single 9V "transistor" battery (NEDA 1604A for alkaline; NEDA 1604 for carbon-zinc). An alkaline 9V battery is factory installed in the instrument. Up to 200 hours of continuous operation can be achieved using an alkaline battery; up to 150 hours using a carbon-zinc battery.

4.3.3 Low Battery Indicator

4.3.4 The 463 will automatically detect and display an arrow (upper left-hand corner of display) when the battery voltage is below 7.0 volts. The first appearance of the arrow signifies a remaining battery life of approximately 20 hours.

4.4 GENERAL FUNCTIONAL CHECK:

NOTE: Prior to operation of the Instrument, review and perform (where applicable) the following notes and checks. These steps can be used also as a general functional check.

a. Connect the black test lead to the COM jack and the red test lead to the V-Ω jack. Short the test leads together.

b. Depress and set the "kΩ" function and "2" range switches.

c. Separate the test leads. The numerical display will blank in the out-of-range condition.

d. Short the test leads together. The display reading will return to .000 ±1 digit.

e. If difficulty is encountered in the above steps, see Section 6, Table 6-1.

4.5 DC VOLTAGE MEASUREMENTS:

a. Review the Safety Precautions in paragraph 4.2.

b. Connect the red test lead to the V-Ω jack and the black lead to the COM jack.

c. Depress the "$\overline{\overline{V}}$" function switch.

d. Depress the appropriate voltage range switch. If the voltage being measured is unknown, begin with the 1000 volt DC range switch.

e. Turn off the power to the device or circuit under test and discharge all capacitors.

CAUTION

Do not attempt to measure voltages on the 1000 VDC range which might be greater than 1000 volts DC.

f. Connect test leads to the circuit being measured.

g. Apply power to the circuit being measured. The Instrument will automatically indicate the correct polarity "—" to indicate negative and no sign to imply positive polarity. The value of the voltage being measured will be indicated on the numerical display.

h. Remove all power from the circuit being measured and discharge all capacitors prior to disconnecting test leads.

4.6 AC VOLTAGE MEASUREMENT:

a. Review the Safety Precautions in Paragraph 4.2.

b. Connect the red test lead to the V-Ω jack and the black lead to the COM jack.

c. Depress the "$\widetilde{V}$" function switch.

d. Depress the appropriate voltage range switch. If the voltage being measured is unknown, begin with the 750 VAC range switch.

CAUTION

Do not attempt to measure voltages on the 750 VAC range which might be greater than 750 volts.

e. Remove all power from the circuit being measured and discharge all capacitors.

f. Connect test leads to the circuit being measured.

g. Apply power to the circuit being measured. The value of the voltage being measured will be indicated on the numerical display.

h. Remove all power from the circuit being measured and discharge all capacitors prior to disconnecting test leads.

4.7 RESISTANCE MEASUREMENTS:

4.7.1 GENERAL

a. Review the Preliminary Notes and Checks in Paragraph 4.3.

b. Connect the red test lead to the V-Ω jack and the black lead to the COM jack.

c. Depress the "kΩ" function switch.

d. Depress the appropriate resistance range switch.

e. If the resistance being measured is connected into

a circuit, be certain that all power is removed from the circuit and all capacitors are discharged. Check for current paths other than through the resistance being measured. These paths can result in a measured value which is lower than the actual value of the resistance being measured.

f. Connect the test leads to the resistance being measured. Be careful not to contact adjacent points, even if insulated, particularly when making high resistance measurements. Some insulators can have relatively low insulation resistance, which can sufficiently shunt the resistance being measured to result in a measured value lower than the actual value.

g. Allow time for the display to stabilize. This procedure is especially important when measuring a high value resistance shunted by a large value of capacitance.

h. Disconnect test leads.

4.7.2 DIODE TEST:

a. Set the function switch to "kΩ" function.

b. Set the range switch to "2" range.

c. To measure the forward resistance of a semiconductor junction, connect the cathode of the diode to the COM terminal and anode to the V-Ω terminal. For Silicon diodes, the Instrument should display .550 or higher. For germanium diodes, the Instrument should display .450 or lower.

d. To measure the reverse resistance of a semiconductor junction, the Instrument should display "overrange."

4.8 DC CURRENT MEASUREMENTS:

a. Review the Safety Precautions in Paragraph 4.2.

b. Depress the "$\overline{\text{mA}}$" function switch.

c. Depress the appropriate current range switch. If the current being measured is unknown, begin with the 2000 range.

d. REMOVE ALL POWER TO THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

e. Connect the red test lead to the mA jack and the black test lead to the COM jack.

f. Open the circuit in which the current is to be measured and securely connect the test leads in series.

WARNING

Ensure that a current range is never connected across a voltage source and that the circuit into which the 463 is connected (in series) does not have a voltage, with respect to ground, exceeding the rated circuit-to-ground voltage of the 463 (refer to Table 1-1, item 6).

g. Apply power to the circuit being measured.

h. The value of current being measured is indicated on the numerical display.

i. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

j. Disconnect the test leads and reconnect the circuit which was originally opened.

4.9 AC CURRENT MEASUREMENTS:

a. Review the Safety Precautions in Paragraph 4.2.

b. Depress the "$\tilde{\text{mA}}$" function switch.

c. Depress the appropriate current range switch. If the current being measured is unknown, begin with the 2000 range.

d. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

e. Open the circuit in which the current is to be measured and securely connect the test leads in series.

WARNING

Ensure that a current range is never connected across a voltage source and that the circuit into which the 463 is connected (in series) does not have a voltage, with respect to ground, exceeding the rated circuit-to-ground voltage of the 463 (refer to Table 1-1, item 6).

f. Connect the red test lead to the mA jack and the black test lead to the COM jack.

g. Apply power to the circuit being measured.

h. The value of the current being measured is indicated on the numerical display.

i. REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED AND DISCHARGE ALL CAPACITORS.

j. Disconnect the test leads and reconnect the circuit which was originally opened.

SECTION V
THEORY OF OPERATION

5.1 OVERALL SYSTEM

5.1.1 The basic system block diagram for the 463 is shown in Figure 5-1.

5.1.2 Signal Conditioning Section: The parameter being measured is connected to the input terminals. The corresponding Signal Conditioning circuits convert this parameter into a proportional DC voltage. The conversion is accomplished by the Attenuator, Current Shunts, Resistance Converter, AC-to-DC Converter, and associated switching.

5.1.3 Analog-To-Digital Converter Section: The Analog-To-Digital (A/D) Converter section changes the DC output voltage from the Signal Conditioning section to digital information. Using a Large-Scale Integration (LSI) circuit, the unique A/D converter automatically eliminates zero error.

5.1.4 Display Section: The Analog-To-Digital (A/D) Converter decodes the BCD into 7-segment information by the onboard decoder-driver. It also includes a backplane drive. The LCD display is driven directly by the Analog-To-Digital converter chip.

5.2 INPUT CIRCUITS

5.2.1 DC Voltage Measurements: The basic DC Voltage circuit is shown in Figure 5-2(A). The DC Voltage being measured is connected to the "V-Ω" and "COM" jacks, attenuated according to the range selected and converted into digital information by the A/D converter.

5.2.2 The A/D Converter provides a basic 200mV

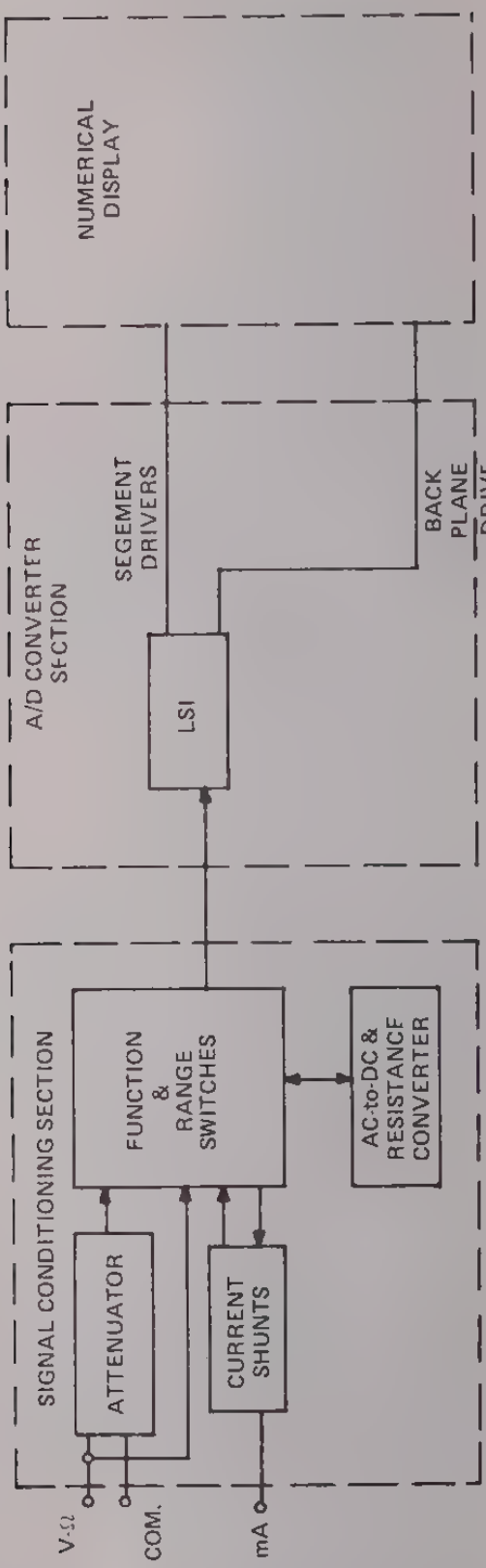

Figure 5-1. Basic System Diagram.

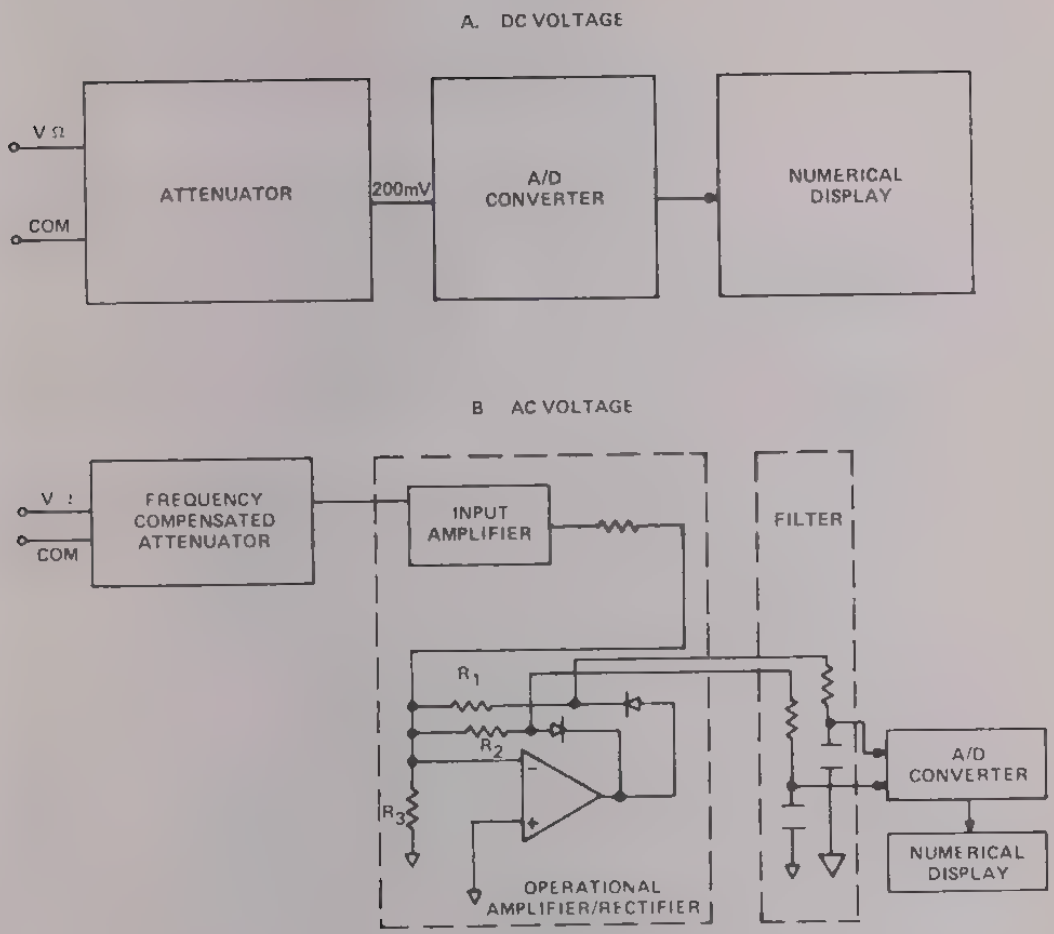

Figure 5-2. Basic Voltage Measurement Circuits.

sensitivity range. The input voltage being measured is attenuated to provide 200mV range by the input divider network. The divider network is used on the 2V, 20V, 200V and 1000 Volt ranges.

5.2.3 AC Voltage Measurement:

5.2.4 The basic AC Voltage measurement circuit is shown in Figure 5-2(B).

5.2.5 The AC voltage being measured is connected to the "V-Ω" and "COM" jacks, attenuated according to the range selected by the range switch selected.

5.2.6 The attenuator is frequency-compensated to provide accurate readings over a wide frequency range.

5.2.7 The Input amplifier achieves high input impedance and presents low output impedance to the converter.

5.2.8 The AC to DC Converter uses an effective full wave operational amplifier/rectifier circuit which provides a basic 200mV full range sensitivity. The converter is average responding but its calibration is based on the rms value of a sine wave.

5.2.9 The output of the Operational Amplifier has two rectifying diodes and two feedback resistors, R1 and R2. These components drive a summing resistor R3. The junction of the summing resistor and the feedback resistor is connected to the amplifier input to provide negative feedback. With a sine wave input signal, the positive half cycles of the output waveform go through one diode, the negative half of the output waveform go through the other diode. Both the positive and negative cycles are filtered and the resulting DC Voltage between the positive and negative cycle is measured by the A/D converter. This full-wave rectified voltage reduces the requirement of filtering.

5.2.10 DC Current Measurements:

5.2.11 The basic DC current measurement circuit is shown in Figure 5-3(A). The current being measured is connected in series with the "mA" and "COM" jacks across the internal precision shunt re-

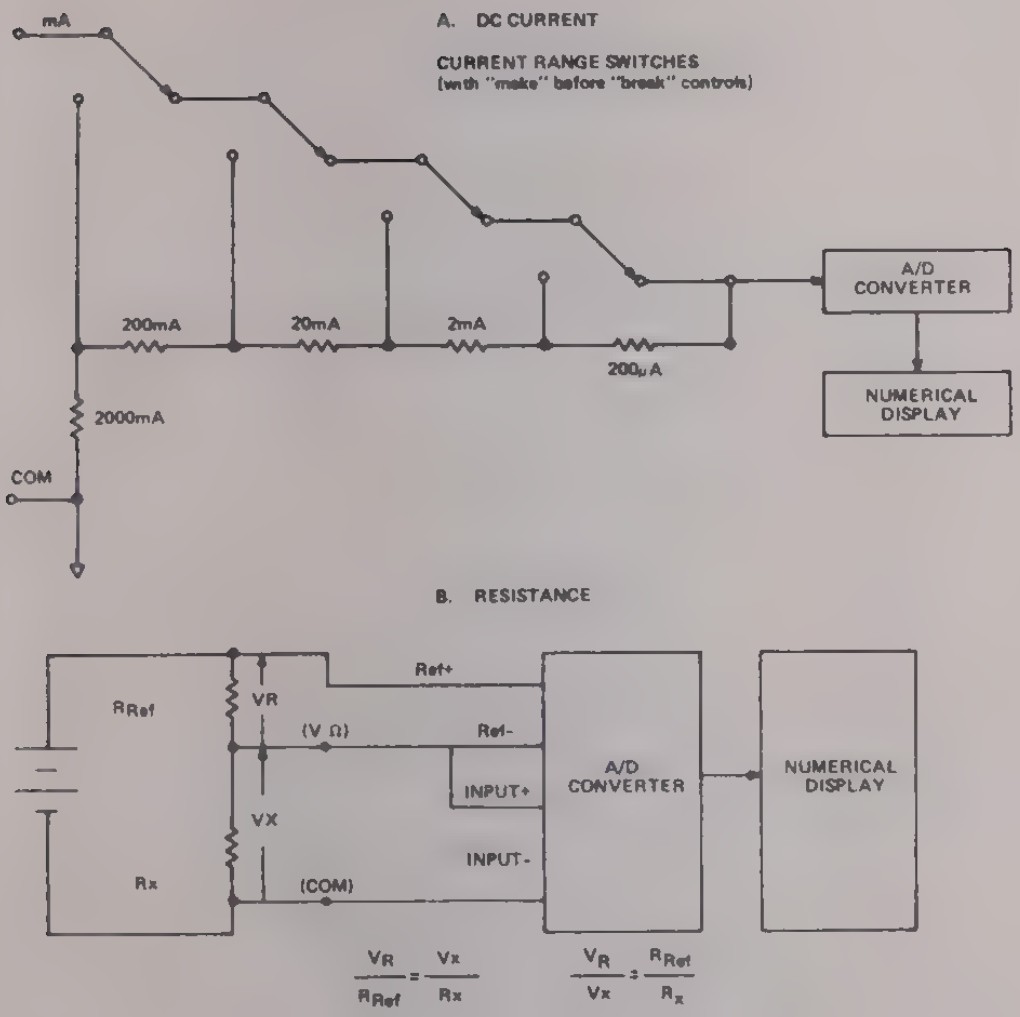

Figure 5-3. Basic DC Current and Resistance Measurement Circuits.

sistance. The value of the shunt resistance depends on the curent range selected. The DC voltage developed across the shunt resistor is measured by the A/D Converter.

5.2.12 The full range sensitivity of the A/D Converter is set for 200mV. The internal shunt resist-

ance for each current equals 200mV divided by the full range current. For example, if the full range current is 200μA, the shunt resistance is 1000 ohms.

5.2.13 AC Current Measurements: The basic AC current measurement circuit is essentially the same as the DC current measurement circuit (paragraph 5.2.10), except that the voltage developed across the internal shunt resistance is measured by the AC voltage measurement circuit.

5.2.14 Resistance Measurements:

5.2.15 The basic resistance circuit is shown in Figure 5-3(B).

5.2.16 The resistance being measured, Rx, is connected to the "V-Ω" and "COM" jacks. A voltage ratio is made by comparing the unknown resistance (Rx) with an internal standard resistance R ref. The voltage ratio is applied to the A/D converter to yield a numerical value which is proportional to the unknown resistance as shown in Figure 5-3(B). The ranges of the resistance measurement circuit are determined by the range switch selected.

5.2.17 For semiconductor junction test, refer to paragraph 4.7.2 diode test.

WARNING

These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

SECTION VI
SERVICING INSTRUCTIONS

6.1 GENERAL

6.1.1 The 463 is carefully designed and constructed with high quality components. By providing reasonable care and following the instructions in this manual, the user can expect a long and useful service life from this Instrument.

6.2 COVER REMOVAL

6.2.1 The rear cover can be removed for servicing by the following procedures:

WARNING

Remove all power and connections to the Instrument before removing the case cover. Do not operate the Instrument with the rear cover removed.

a. Depress the POWER switch to the OFF position.

b. Disconnect the test leads from the Instrument.

c. Turn the two screws on the back cover counterclockwise until the rear cover is removed. (The two screws will remain in the cover.)

d. Reverse this procedure when replacing the cover.

6.3 BATTERY INSTALLATION/ REPLACEMENT PROCEDURE

6.3.1 Use the following procedure to install or replace the battery:

a. Set the POWER switch to the OFF position.

b. Remove both test leads from external circuit

connections and from the 463 input terminals.

c. Remove the rear cover by turning the two screws counterclockwise.

WARNING

Remove both test leads from input terminals before removing the cover. Do not operate the Instrument with the rear cover removed.

d. Lift the battery from the compartment and remove the battery connector.

e. Press the battery connector on the new battery and return the battery to the compartment.

f. Replace the rear cover.

NOTE: When the batteries reach the end of their useful life, replace them promptly. Failure to do so may result in corrosion at the battery contacts.

6.4 FUSE REPLACEMENT

6.4.1 Both AC and DC current functions are protected up to 2 amps with two fuses, F1 and F2. The fuses are connected in series and are accessible with the removal of the rear cover (Figure 6-1).

6.4.2 Type:

F1: 3AG, 2A, 250V, Normal blow.

F2: BBS, 3A, 600V

6.4.3 Fuse Replacement Procedure

a. Set the POWER switch to the OFF position.

b. Remove both test leads from external circuit connections and from the 463 input terminals.

c. Remove the rear cover by turning the two screws counterclockwise.

WARNING

Remove both test leads from input terminals before removing the cover. Do not operate the Instrument with the rear cover removed.

d. Carefully remove and replace the defective fuse.

CAUTION

Do NOT replace a blown fuse with a larger-rated fuse or a slower time lag characteristic than those specified.

e. Replace the rear cover.

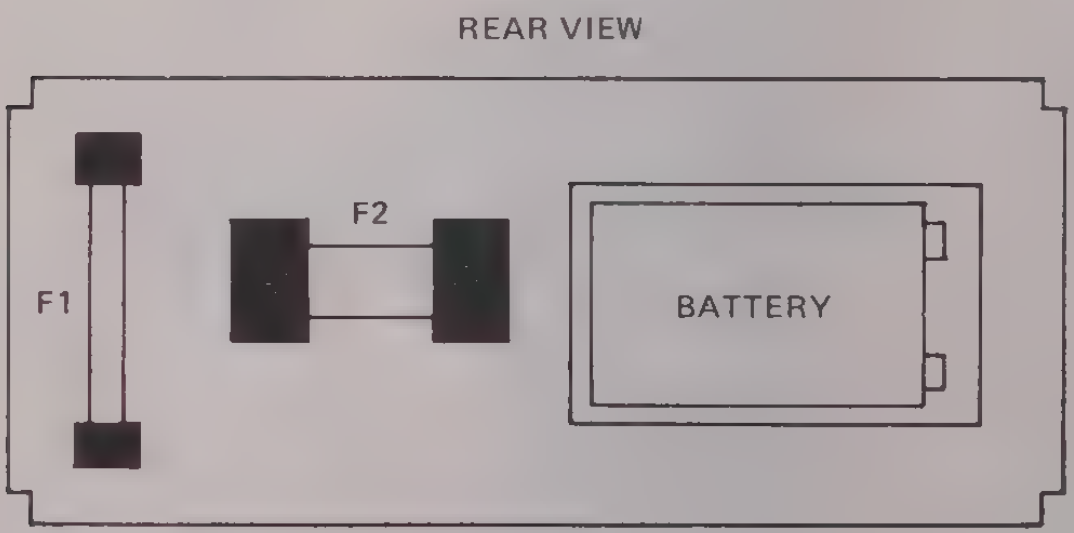

Figure 6-1. Fuse Location, 463.

6.5 TROUBLESHOOTING

6.5.1 If the Instrument does not yield satisfactory results, follow these procedures before attempting maintenance on the Instrument.

a. Review and comply with paragraph 4.3, General Functional Check.

b. Check that all switches are positioned correctly for the parameter and range of the value being measured and that the measurement situation is within the rating of the Instrument.

c. Be sure that the battery is properly installed (paragraph 6.3).

d. Ensure that the environment in which the Instrument is being used is within the instrument specifications.

e. Inspect the device being measured and the measurement test set-up to ensure that proper shielding and grounding techniques have been used. Also, consider whether the Instrument is significantly affecting the circuit being measured.

6.5.2 If the steps taken in paragraph 6.5.1 do not yield satisfactory results, refer to the troubleshooting chart (Table 6-1). If further assistance is needed, contact an Authorized Service Center.

Table 6-1. Troubleshooting Chart

SYMPTOM:
Arrow (←) appears on display.

PROBABLE CAUSES:
Battery reached the end of its useful life.

CURE:
Replace the battery as noted in paragraph 6.3.

SYMPTOM:
No display or faded display when the Instrument is turned "ON."

PROBABLE CAUSES:
Battery defective, not installed properly, making poor contact, or missing.

CURE:
Remove cover and check that the battery is installed correctly and making good contact. (Refer to paragraph 6.3 for replacement.)

SYMPTOM:
Indications fluctuate and/or drift, even though indication is satisfactory at 000 with the input terminals shorted, and at 1000 counts when using a stable and low impedance source.

PROBABLE CAUSES:
Fluctuations, and/or drift are being generated by the circuit being measured or the measurement test set up.

CURE:
Use proper shielding grounding techniques and connections to minimize "pick-up" of unwanted signals due to ground loops, poor connections, and capacitive and/or inductive coupling.

SYMPTOM:
Slow response. Operation OK when using a low impedance input.

PROBABLE CAUSES:
Parameter being measured has a high source impedance.

CURE:
None required.

SYMPTOM:
Accuracy not within specifications when checked with a stable higher accuracy (at least 5 times better) low impedance (voltage measurements) source.

PROBABLE CAUSES:
Instrument is out of calibration.

CURE:
Contact the nearest Authorized Service Center.

SYMPTOM:
Operation normal on all functions and ranges except AC and DC Current.

PROBABLE CAUSES:
Current fuse F1 open.

CURE:
Replace fuse F1 (paragraph 6.4.).

SYMPTOM:
Operation normal on all functions and ranges except AC and DC Current (F1 checks OK).

PROBABLE CAUSES:
Current fuse F2 open.

CURE:
If F2 has been blown, a large amount of energy has been applied to the current ranges. Circuit conditions must be corrected before replacing F2.

6.6 REPLACEMENT PARTS AND SCHEMATIC DIAGRAM

6.6.1 This section contains information for ordering replacement parts and shows the Schematic Diagram (Figure 6-2). Table 6-2 lists parts in alphanumeric order of their reference designators and indicates the description (Refer to Table 1-2 for Items and Accessories Furnished With This Instrument.)

6.6.2 To obtain replacement parts, address order to the nearest Authorized Service Center (listed on the last pages of this manual). Refer to paragraph 2.3.1 for ordering instructions.

Table 6-2. Replacement Parts

Symbol	Description	Part No.
B1	Battery, 9V Alkaline	5-114907
F1	Fuse, 2A, 250V, 3AG Normal-Blow	1-112911

F2	Fuse, 3A, 600V, BBS	6-110906
C1	Capacitor, Variable, 4.5-60pF	6-110125
C2	Capacitor, Variable, 2-15pF	6-111158
C3	Capacitor.100pF ±5%, 1kV, NPO	5-113217
C4	Capacitor, 820pF ±5%, 500V	5-114995
C5	Capacitor, 4.7pF ±5%, 1kV, NPO	5-114988
C6	Capacitor, 15pF ±5%, 1kV, NPO	5-114989
C7	Capacitor, .047μF ±20%, 630V	6-111599
C8,C9,C11	Capacitor, .10μF —20 +80%, 10V	5-113214
C10,C13	Capacitor, 15μF —20 +50%, 16V	5-115534
C12	Capacitor, 30pF ±20%, 1kV	5-110935
C14,C15	Capacitor, 1.0μF ±10%, 16V	5-115531
C16	Capacitor, .1μF ±20%, 100V	6-113612
C18	Capacitor, .22μF ±10%, 250V	6-110364
C19	Capacitor, .47μF ± 10%, 100V	6-111168
C17,C20	Capacitor, .047μF ± 5%, 100V	5-117202
C21	Capacitor, 220pF ±5%, 25V	5-117571
C22	Capacitor, 1pF ±5%, 1kV, NPO	6-111241
D3,D4	Diode, Silicon, 1N914	5-112004
D5	Diode, Silicon, 1N5059	5-113826
D6	Diode, Silicon Bridge Rectifier, MDA200	6-111240
IC1	Integrated Circuit, OP-Amp., TL0626P	6-110905

IC2	Integrated Circuit, 3½ Digit A/D Converter, ICL7106CPL	6-110920
IC3	Integrated Circuit, CMOS Quad Exclusive-OR Gate, CD4070	6-111150
IC4	Integrated Circuit, CMOS Qual Bilateral Switch, CD4066	6-111593
MOV1-4	Resistor, Special, Varistor, V430MA7B	6-110694
Q1	Transistor, FET, 2N5458	5-112747
Q2	Transistor, PNP Silicon 2N4248	5-115484
Q3,Q4	Transistor, NPN Silicon, 2N4123	5-115931
R1,R2	Potentiometer, 500Ω ±20%, Cermet	6-111243
R3-R7	Resistor, Special, Matched Set: R3-9MegΩ R4-900kΩ R5-90kΩ R6-9.0kΩ R7-1.0kΩ	6-111234
R8	Resistor, 100Ω ±.1%, ⅛W	6-111153
R9	Resistor, .1Ω and .9Ω	6-111235
R11	Resistor, 8.96Ω ±.5%, ¼W	6-111309
R12	Resistor, 90Ω ±.25%, ¼W	5-116272
R13	Resistor, 900Ω ±.25%, ¼W	5-116273
R14	Resistor, 22kΩ ±5%, ¼W	5-118163
R15	Resistor, 330kΩ ±1%, 1W	6-111245
R16,R17	Resistor, 10MegΩ ±5%, ¼W	5-116632
R18,R30	Resistor, 6.8kΩ ±5%, ¼W	5-118256
R19	Resistor, 1.2kΩ ±10%, 1W	5-116891

R20,R23, R37	Resistor, 180kΩ ±5%, ¼W	5-116633
R22	Resistor, 5.0kΩ ±1%, ¼W	5-116677
R24,R25	Resistor, 10.0kΩ ±1%, ¼W	6-110497
R26,R27, R36,R46	Resistor, 100kΩ, ±5%, ¼W	5-118168
R28,R29,	Resistor, 47kΩ ±5%, ¼W	5-119647
R31	Resistor, 10kΩ ±5%, ¼W	5-118161
R32	Resistor, 10kΩ, ±5%, ¼W	6-111253
R33	Resistor, 100kΩ ±5%, ½W	5-118625
R34	Resistor, 4.0kΩ ±1%, ¼W	5-117695
R35	Resistor, 1MegΩ ±5%, 1W	6-111248
R39	Resistor, 220kΩ ±5%, ¼W	5-119707
R40	Resistor, 43.2kΩ ±1%, ⅛W	6-111254
R41-R43	Resistor, 1MegΩ ±5%, ¼W	5-118305
R44	Potentiometer 470kΩ ±20%, Carbon	6-111254
ZD1	Diode, Zener, 5.1V ±5%, 1N751A	5-113197
ZD2	Diode, Low Voltage Reference 1.22V, MPS-5010	6-111151
ZD3	Diode, Zener, 12V ±5%, 1N4742A	5-113866
SW1-SW6	Switch, Range	6-111148
SW7-SW12	Switch, Function	6-111149
	Button, Red	6-110113
	Button, Black	6-110114
	Button, Gray	6-110115
	Readout, 3½ digit LCD	6-111152

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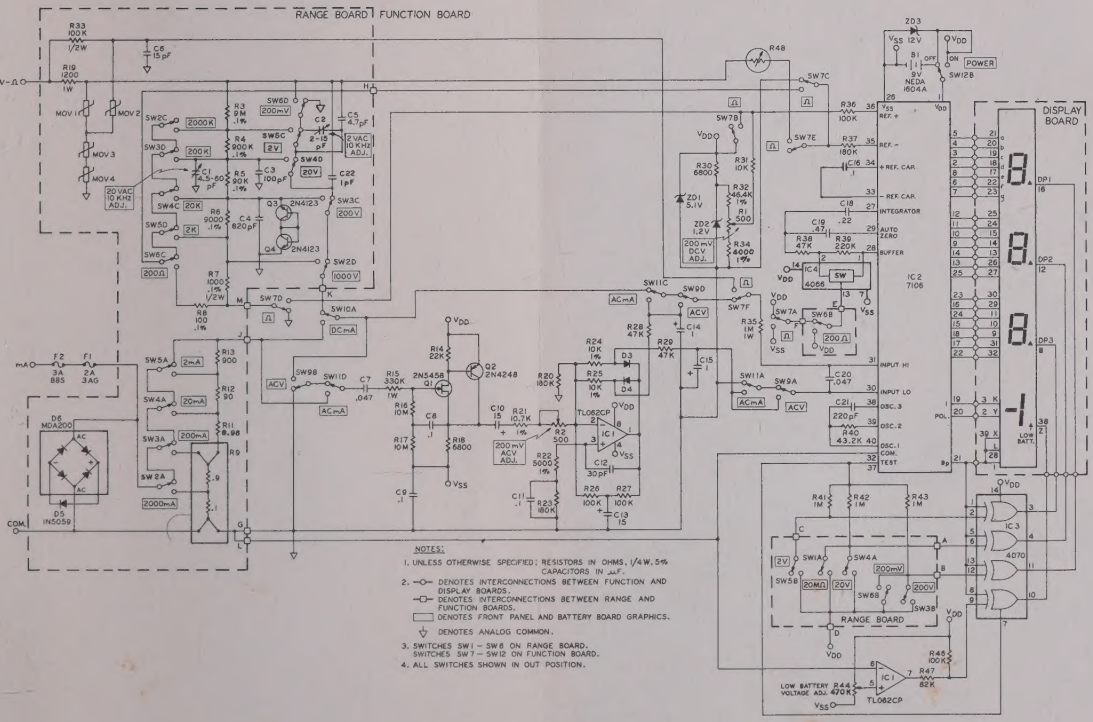
RANGE BOARD FUNCTION BOARD
DISPLAY BOARD
RANGE BOARD
NOTES:
1. UNLESS OTHERWISE SPECIFIED; RESISTORS IN OHMS, 1/4W, 5% CAPACITORS IN μF.
2. DENOTES INTERCONNECTIONS BETWEEN FUNCTION AND DISPLAY BOARDS.
DENOTES INTERCONNECTIONS BETWEEN RANGE AND FUNCTION BOARDS.
DENOTES FRONT PANEL AND BATTERY BOARD GRAPHICS.
DENOTES ANALOG COMMON.
3. SWITCHES SW1 – SW6 ON RANGE BOARD.
SWITCHES SW7 – SW12 ON FUNCTION BOARD.
4. ALL SWITCHES SHOWN IN OUT POSITION.

Figure 6-2. Schematic Diagram, 463.

Quality is the indispensable component of every Simpson instrument . . . . . .

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